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(54) **IMAGE READING DEVICE INCLUDING READING UNIT COUPLED WITH FLAT CABLE**

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(52) **U.S. Cl.**

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USPC 358/497, 494, 474, 505; 250/234-236; 174/117 FF, 99 R

See application file for complete search history.

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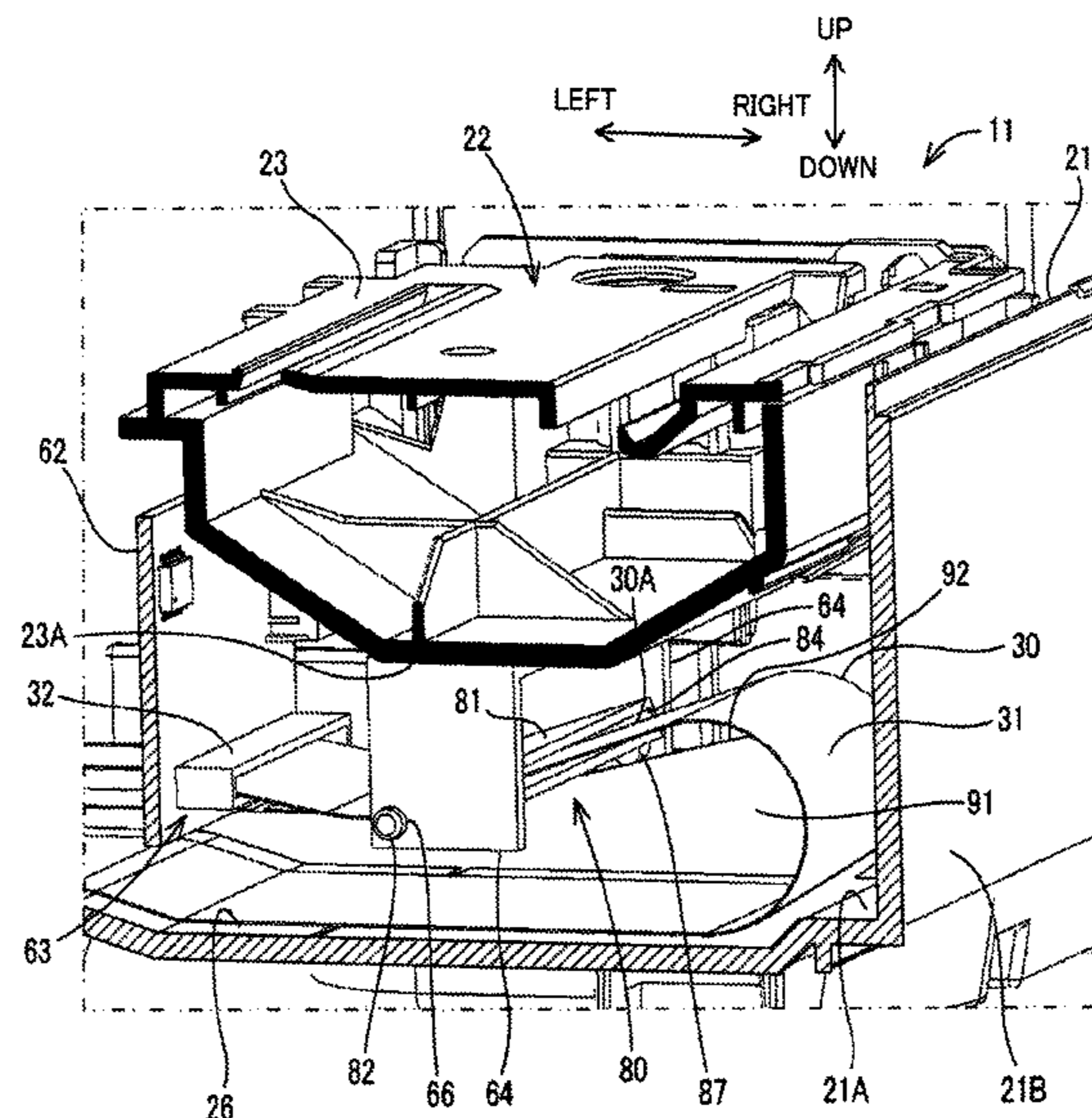
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(57) **ABSTRACT**

An image reading device includes a housing, a reading unit, a flat cable, and a support member. The reading unit is movably provided in the housing and configured to reciprocally move from a start position to an end position in a reading range. One end of the flat cable is coupled with the reading unit and a predetermined portion thereof on the other end side is fixed to the housing. The flat cable is stored in a bent state in the housing. The support member is provided in the reading unit and configured to support the flat cable and displace, in response to a movement position of the reading unit, a support point of the flat cable in an up-down direction with respect to a coupling portion coupling the one end of the flat cable with the reading unit.

9 Claims, 9 Drawing Sheets



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FIG. 1

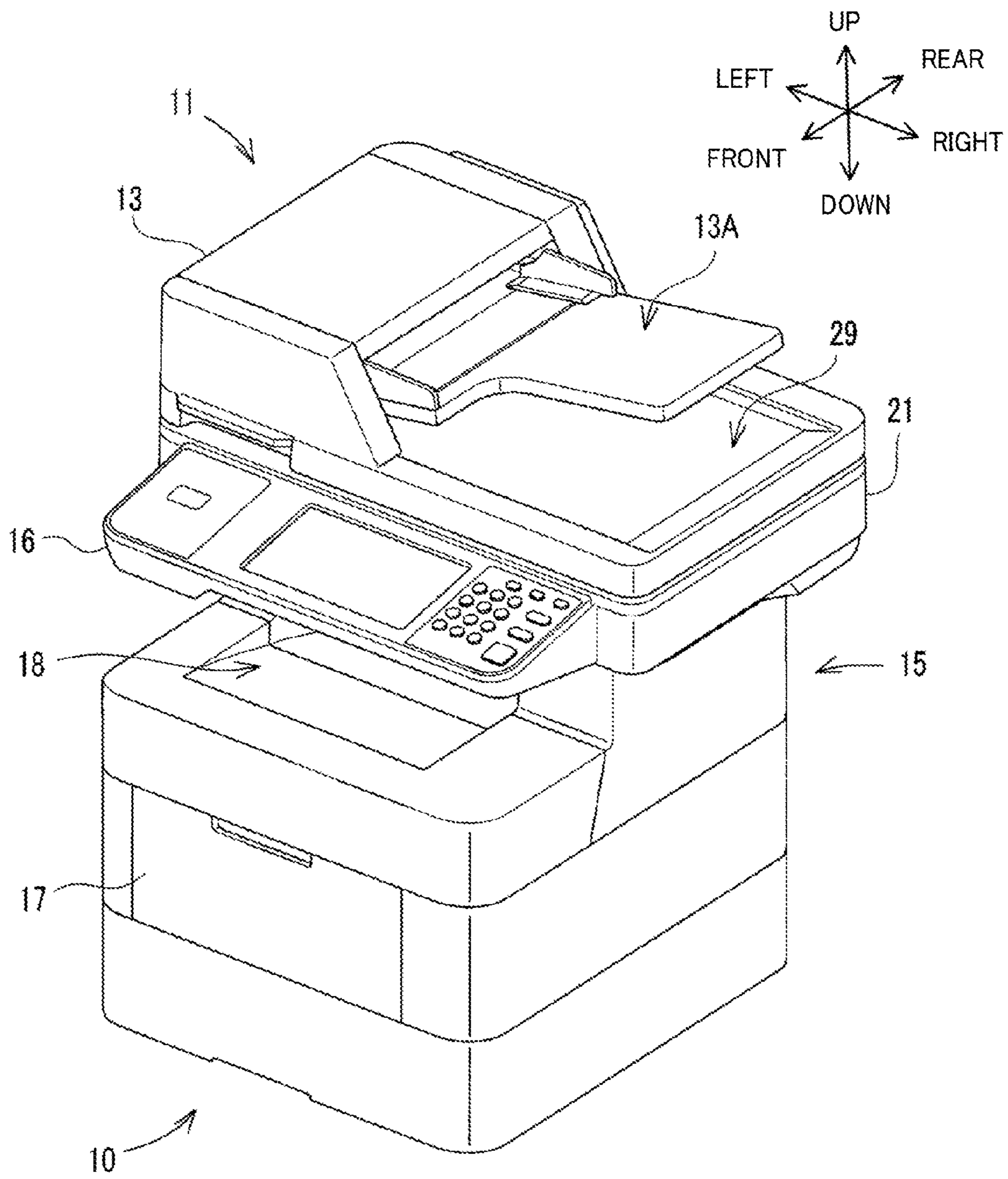


FIG. 2

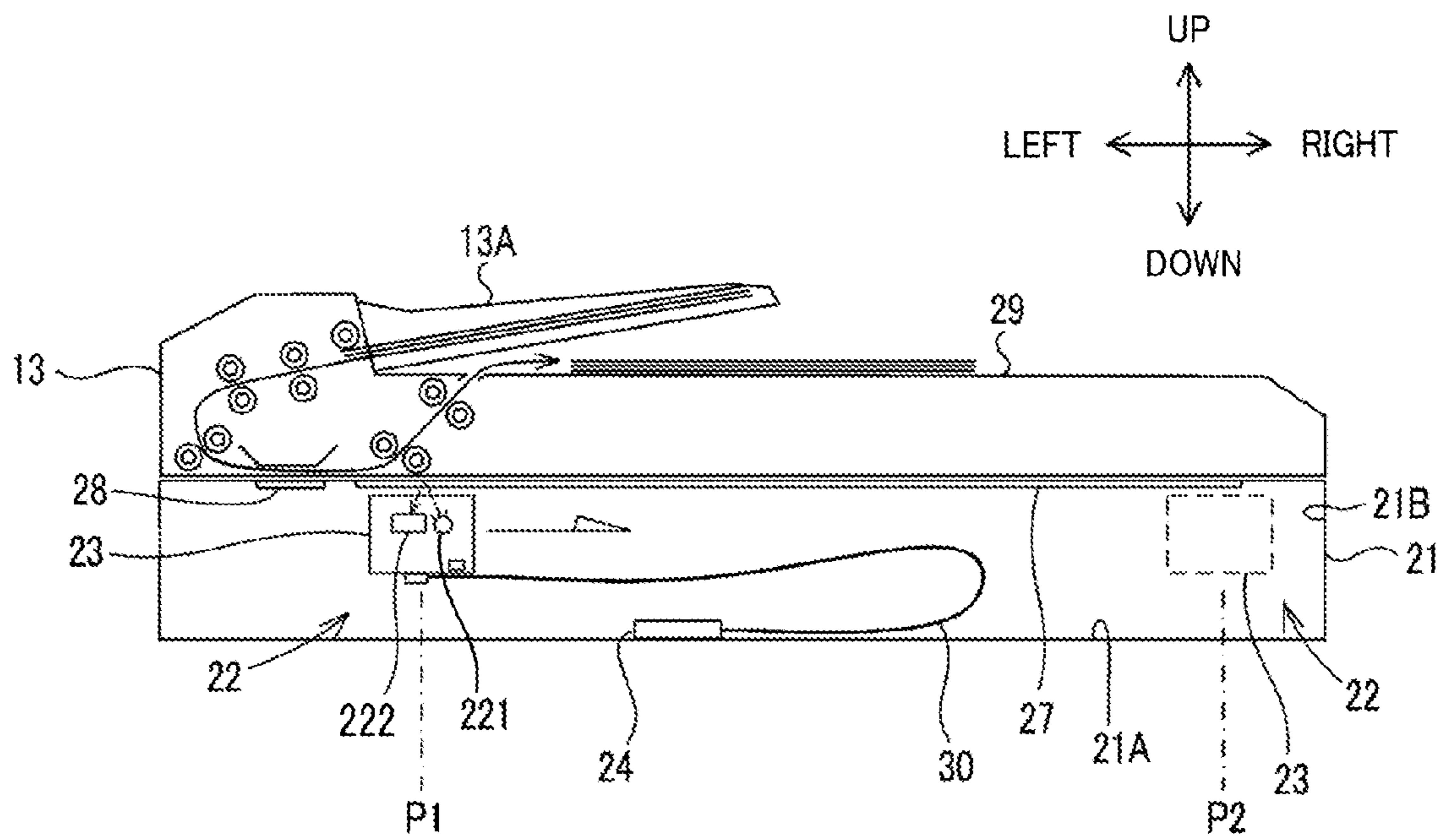


FIG. 3

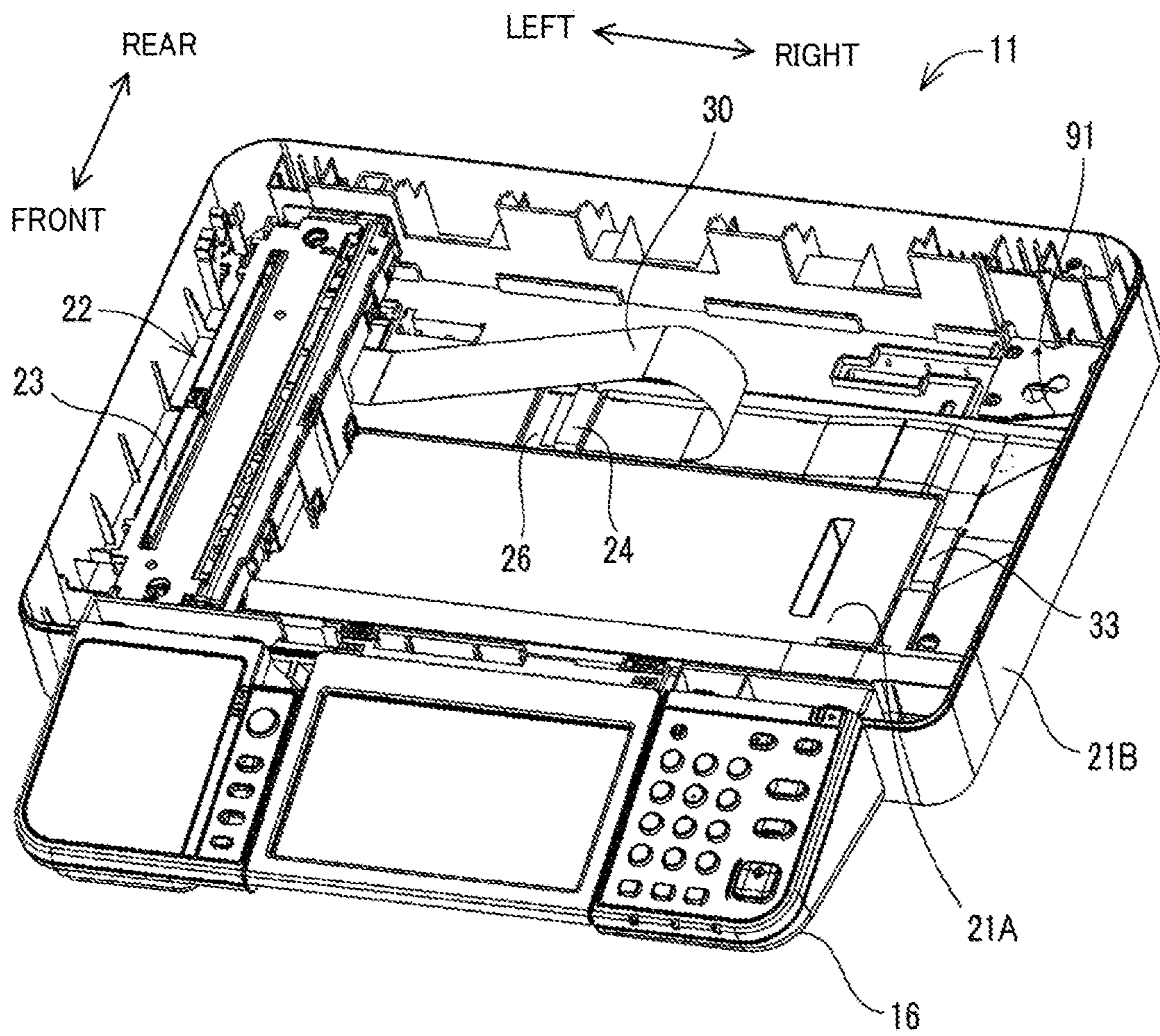


FIG. 4

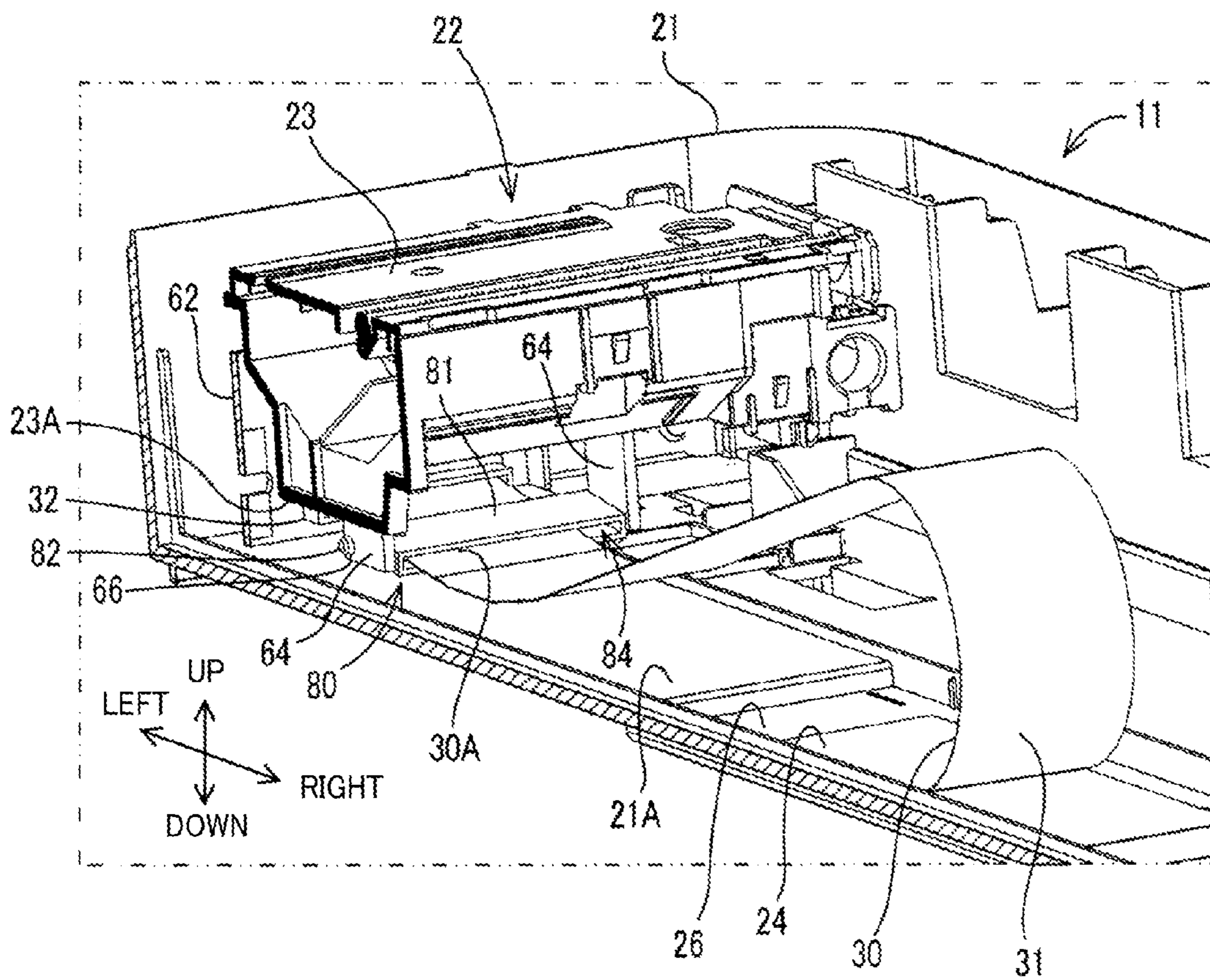


FIG. 5

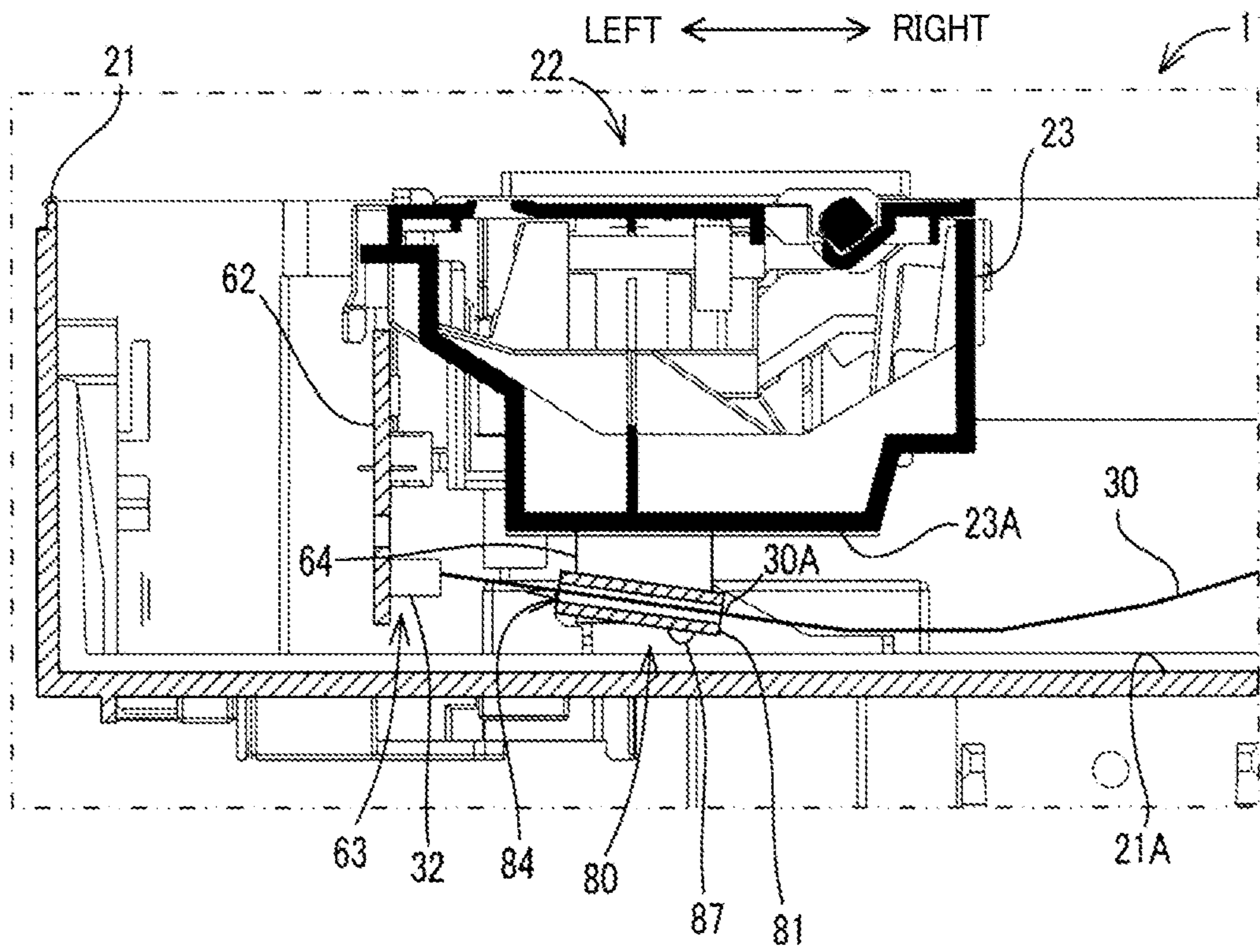


FIG. 6

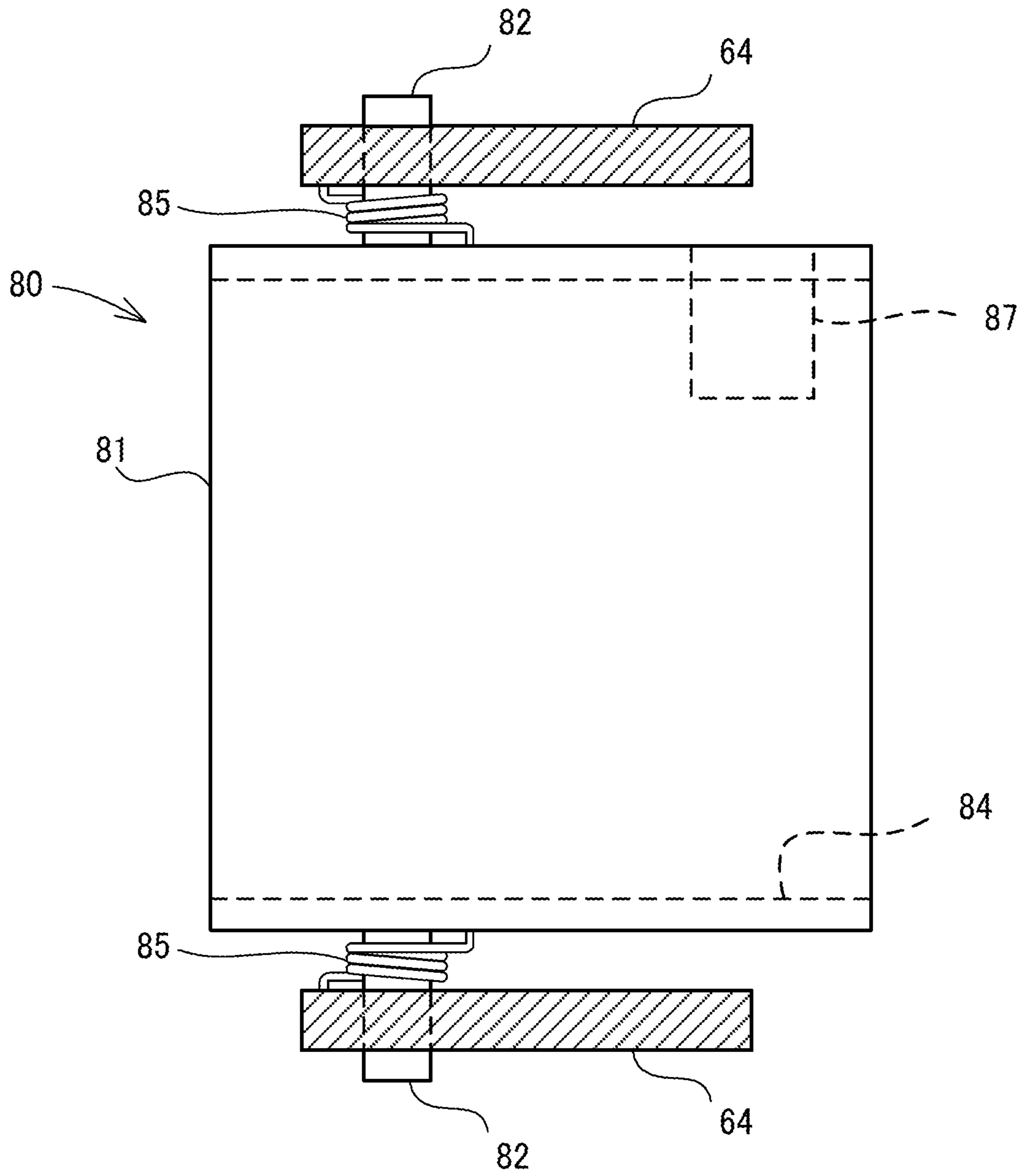


FIG. 7

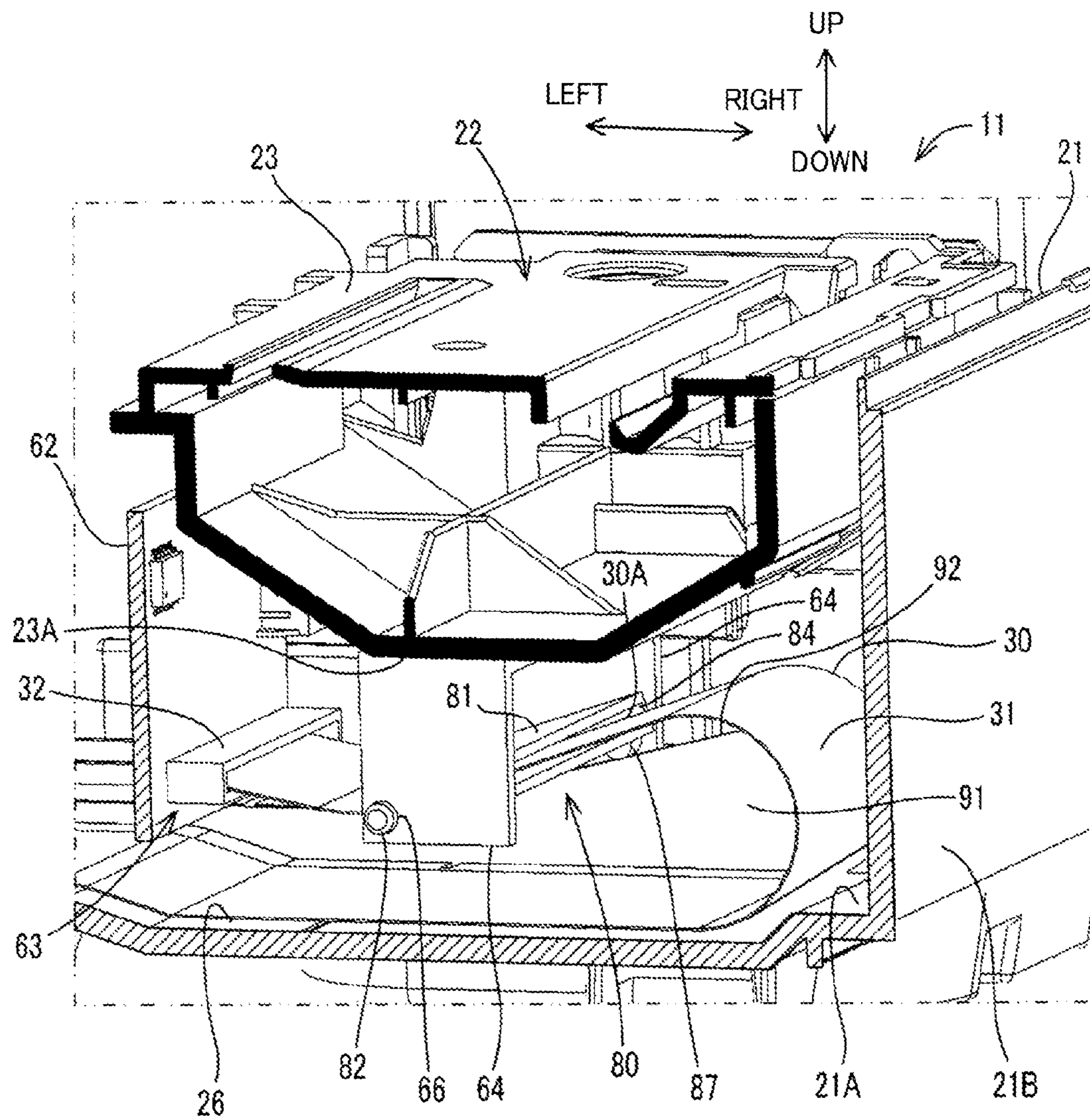
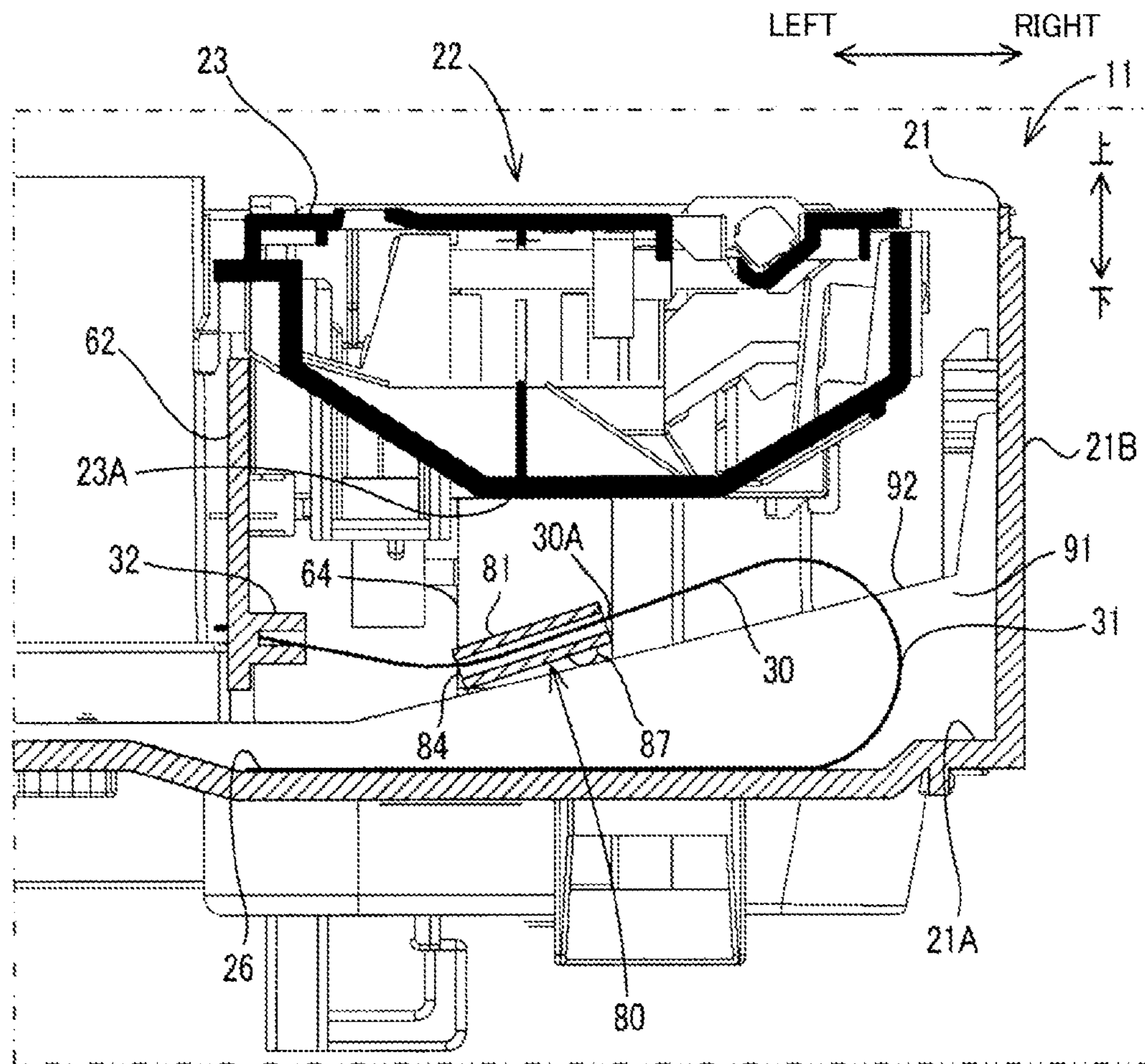


FIG. 8



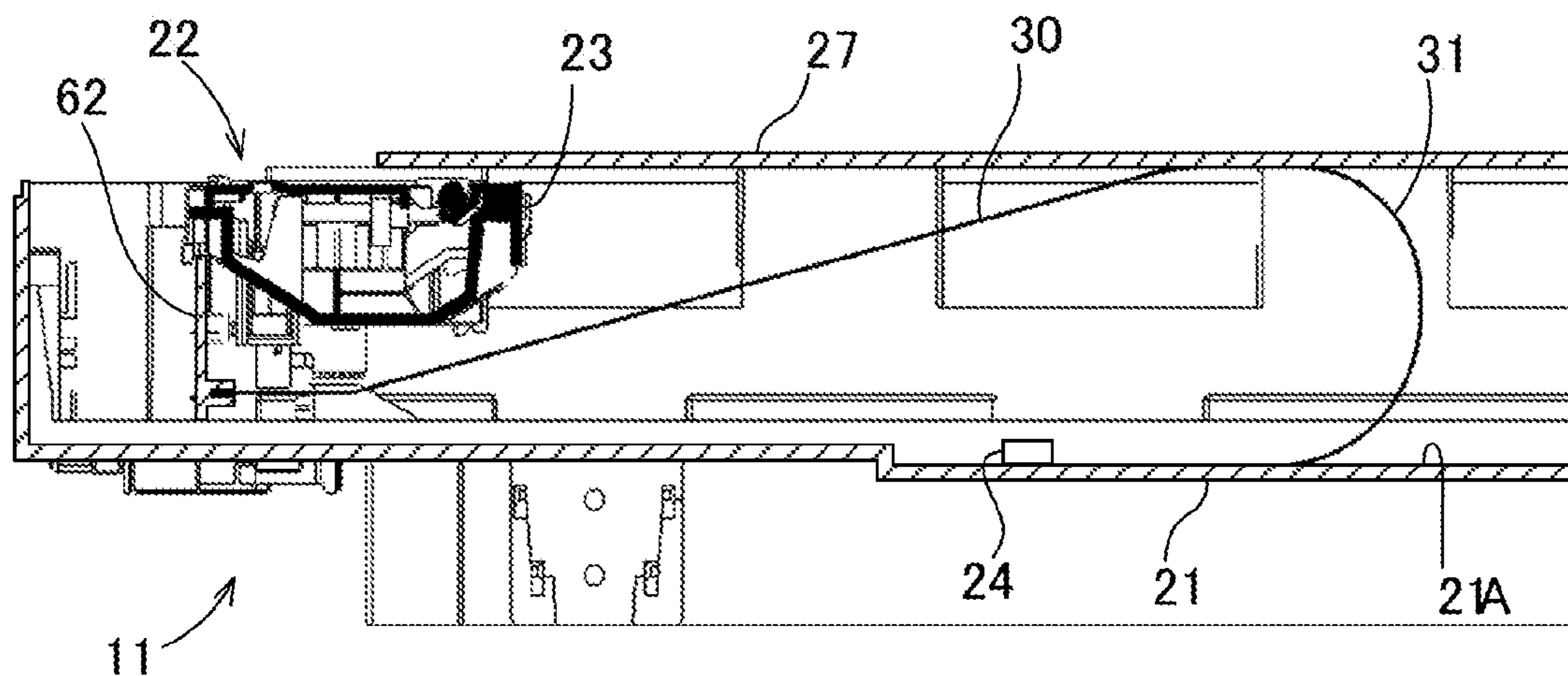


FIG. 9A

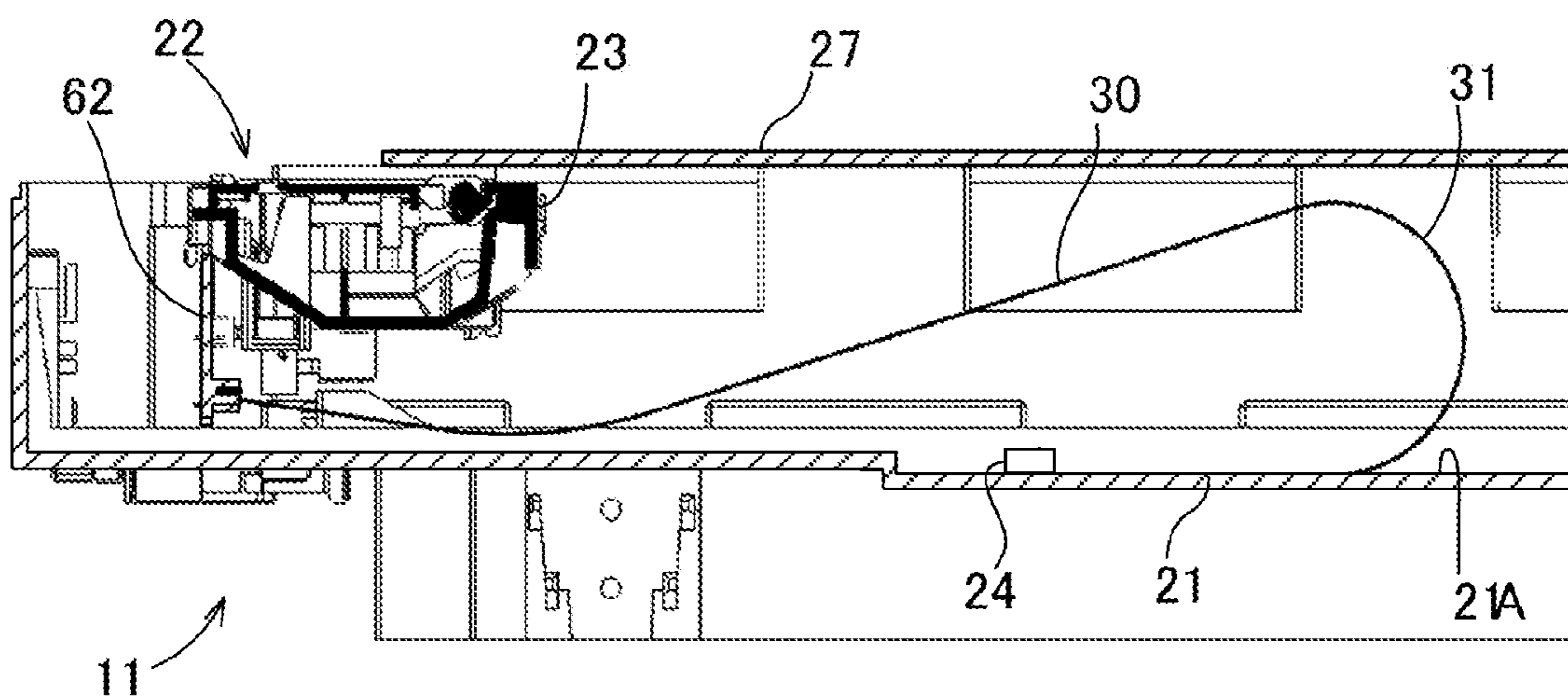


FIG. 9B

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IMAGE READING DEVICE INCLUDING READING UNIT COUPLED WITH FLAT CABLE

INCORPORATION BY REFERENCE

This application is based upon and claims the benefit of priority from the corresponding Japanese Patent Application No. 2015-105169 filed on May 25, 2015, the entire contents of which are incorporated herein by reference.

BACKGROUND

The present disclosure relates to an image reading device that includes a reading unit coupled with a flat cable.

An image reading device includes a reading unit that includes: a reading sensor such as a CIS in which a plurality of imaging elements are arranged in a main scanning direction; a light-emitting element, such as an LED, configured to emit light to an imaging target; and optical components such as a lens and a mirror. The image reading device has a transparent, flat plate-like contact member, wherein a document sheet, from which an image is to be read, is placed on an upper surface of the contact member. The reading unit is configured to be reciprocally moved along the back surface of the contact member in a housing of the image reading device. The reading unit reads an image from a document sheet by, while moving, irradiating light toward the back surface of the contact member and receiving reflection light thereof. A flexible-type flat cable (hereinafter referred to as "FFC") is connected to the reading unit, and control signals and data are communicated between the reading unit and a control portion via the FFC.

Since the reading unit reciprocally moves in the housing as described above, the FFC is stored in the housing in a bent state forming the shape of letter U in a cross section so that it can follow the movement of the reading unit. When the reading unit moves, the FFC expands and contracts following the movement of the reading unit, while keeping the bent state. The FFC has a repulsive force (restoring force) against the bending, and thus, when the reading unit moves to a position distanced from a bending part of the FFC, the bending part becomes large due to the repulsive force and the bending part may contact the back surface of the contact member. In connection with this, if the housing is made tall to accommodate the maximum size of the bending part, the size of the housing in the height direction becomes large. There are known some configurations conceived for the problem to be solved. For example, there is known a configuration where the reading unit is provided with a pressing portion for separating the FFC from the contact member. In addition, there is known a configuration where the FFC extends out diagonally downward from a connection portion between the reading unit and the FFC.

SUMMARY

An image reading device according to an aspect of the present disclosure includes a housing, a reading unit, a flat cable, and a support member. The reading unit is movably provided in the housing and configured to reciprocally move from a start position to an end position in a reading range. One end of the flat cable is coupled with the reading unit and a predetermined portion thereof on the other end side is fixed to the housing. The flat cable is stored in a bent state in the housing. The support member is provided in the reading unit and configured to support the flat cable and displace, in

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response to a movement position of the reading unit, a support point of the flat cable in an up-down direction with respect to a coupling portion coupling the one end of the flat cable with the reading unit.

This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description with reference where appropriate to the accompanying drawings. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter. Furthermore, the claimed subject matter is not limited to implementations that solve any or all disadvantages noted in any part of this disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of an image forming apparatus including an image reading device according to an embodiment of the present disclosure.

FIG. 2 is a diagram showing an inner configuration of the image reading device.

FIG. 3 is a perspective view showing an inner configuration of a housing of the image reading device.

FIG. 4 is a perspective view showing a swaying support portion included in a reading unit of the image reading device.

FIG. 5 is a cross-sectional view showing a peripheral mechanism of the reading unit located at a start position in a reading range.

FIG. 6 is a top view of the swaying support portion of the reading unit.

FIG. 7 is a perspective view showing a peripheral mechanism of the reading unit located at an end position in the reading range.

FIG. 8 is a cross-sectional view showing the peripheral mechanism of the reading unit located at the end position in the reading range.

FIG. 9A and FIG. 9B are cross-sectional views showing an image reading device that does not include the swaying support portion.

DETAILED DESCRIPTION

The following describes an embodiment of the present disclosure with reference to the drawings. It should be noted that the following embodiment is an example of a specific embodiment of the present disclosure and should not limit the technical scope of the present disclosure.

Outlined configurations of an image reading device **11** according to an embodiment of the present disclosure and an image forming apparatus **10** including the same are described with reference to FIG. 1 to FIG. 3. It is noted that FIG. 3 shows a state where an upper-part of a housing **21** of the image reading device **11** has been removed.

The image forming apparatus **10** is a multifunction peripheral having a plurality of functions such as an image reading function, a facsimile function, and an image forming function. As shown in FIG. 1, the image forming apparatus **10** includes the image reading device **11**, an automatic document feeder **13** (hereinafter referred to as an ADF **13**), an electrophotographic image forming portion **15**, an operation/display portion **16**, a sheet feed cassette **17**, and a sheet discharge portion **18**. It is noted that although the present embodiment describes the image forming apparatus **10** including the image reading device **11** as one example, the present disclosure is not limited to this.

The image reading device **11** is attached to an upper part of the image forming apparatus **10**. The ADF **13** is provided in the image reading device **11**. The image reading device **11** reads image data from a document sheet. As shown in FIG. **2**, the image reading device **11** includes a reading unit **22**, a contact member **27**, a contact member **28**, a document sheet pressing **29**, and a housing **21**. Some of the components are stored in the housing **21**.

The contact member **27** and the contact member **28** are both attached to an upper part of the housing **21**. The contact member **27**, on which a document sheet, an image-reading target, is placed, is held horizontally by the housing **21**. The contact member **28** transmits light emitted from the reading unit **22** so that the light is irradiated on a document sheet conveyed by the ADF **13**, and is held horizontally by the housing **21**. The contact members **27** and **28** are each formed in the shape of a flat plate, and made of a transparent material (for example, glass or transparent resin).

The contact member **28** is an elongated member extending in a main scanning direction (the front-rear direction in FIG. **1**), and is a transparent member formed in a shape of a plate. In addition, the width of the contact member **28** is narrow in a sub scanning direction (a direction perpendicular to the main scanning direction).

As shown in FIG. **2**, the reading unit **22** is a device for reading an image from a document sheet conveyed by the ADF **13**, or from a document sheet placed on the contact member **28**. The reading unit **22** includes a light source **221** and an imaging element **222**. These optical members are stored in a carriage **23** that constitutes a main frame of the reading unit **22**.

The carriage **23** of the reading unit **22** is configured to be reciprocally moved in the left-right direction by a well-known moving mechanism that uses a drive device such as a stepping motor. In the present embodiment, the carriage **23** is configured to be reciprocally moved from a start position **P1** to an end position **P2** during an operation to read an image from a document sheet placed on the contact member **27**. This makes it possible for the reading unit **22** to move reciprocally between the start position **P1** and the end position **P2**. Here, the start position **P1** is below a left-end position of the document sheet placed on the contact member **27**. In addition, the end position **P2** (a position represented by a dotted line in FIG. **2**) is distanced from the start position **P1** rightward by a maximum reading range. In the present embodiment, the end position **P2** is set in the vicinity of a right-side wall **21B** of the housing **21**.

The moving mechanism may be, for example, a belt transmission mechanism or a gear transmission mechanism that is configured to transmit a driving force from the motor to the carriage **23**. In the image reading device **11**, in the state where a document sheet is placed on the contact member **27** and the document sheet pressing **29** is closed, the reading unit **22** is reciprocally moved in the left-right direction below the document sheet, in the housing **21** by the drive device. While the reading unit **22** is moving rightward, light irradiated from the light source **221** toward the contact member **27** is scanned, and reflection light thereof is received by the imaging element **222**. In this way, the image of the document sheet is read.

A flexible flat cable (FFC) **30** is provided in the housing **21**. The FFC **30** electrically connects the reading unit **22** to the control portion, and is composed of conducting wires covered with insulating resin. An end of the FFC **30** is electrically connected to the reading unit **22**. Specifically, a connector **32** (see FIG. **4**) is attached to an end of the FFC **30**, and the connector **32** is coupled with a connection

portion **63** (an example of the coupling portion of the present disclosure, see FIG. **4**) of a control board **62** of the reading unit **22**.

A fixing portion **24** for fixing the FFC **30** is provided on a bottom surface **21A** of the housing **21**. Specifically, the fixing portion **24** is provided on a bottom portion of a wide groove **26** (see FIG. **3**) which is formed in the bottom surface **21A** to extend in the left-right direction. As shown in FIG. **3**, the groove **26** extends, in the bottom surface **21A**, linearly from near the center to the right in the left-right direction, bends at right angle at the right-side wall **21B**, and extends linearly to the front along the inner surface of the right-side wall **21B**. A part of the FFC **30** that extends from the fixing portion **24** to connect to the control portion is stored in the groove **26** in the state of creeping on the bottom portion thereof, being bent as necessary and reaching a connector **33** provided on the front side. The connector **33** electrically connects, directly or via another cable, the other end of the FFC **30** to the control portion.

In the present embodiment, the fixing portion **24** fixes the FFC **30** to the bottom surface **21A** in the state where a part of the FFC **30** extending from the fixing portion **24** to the reading unit **22** is bent. That is, an end of the FFC **30** is coupled with the reading unit **22** via the connector **32**, and a predetermined portion on the other end side of the FFC **30** is fixed to the bottom surface **21A** by the fixing portion **24**. The other end of the FFC **30** is connected to the control portion via the connector **33**. With this configuration, the FFC **30** is stored in the housing **21** in the state where a part thereof extending from the fixing portion **24** to the reading unit **22** is bent, such that the FFC **30** can follow the reciprocal movement of the carriage **23**.

Meanwhile, as shown in FIG. **9A**, if the FFC **30** is extending horizontally from the reading unit **22** when the reading unit **22** is at the start position **P1**, a bending part **31** of the FFC **30** may become large in bending diameter due to the restoring force and contact the contact member **27**. On the other hand, as shown in FIG. **9B**, if the FFC **30** is pressed down so as to extend downward from the reading unit **22**, the bending diameter of the bending part **31** does not become excessively large and the bending part **31** is prevented from contacting the contact member **27**. However, if the reading unit **22** moves to the end position **P2** (see FIG. **2**) while the FFC **30** is pressed down, the bending diameter of the bending part **31** becomes too small at the end position **P2**, and an excessive load is applied to the FFC **30**. As a result, the FFC **30** may be broken, and in some cases, the conducting wires therein may be disconnected. In the present embodiment, a swaying support portion **80** that is described below is provided in the reading unit **22**. This prevents the contact member **27** from contacting the FFC **30**, and prevents an excessive bending of the bending part **31** of the FFC **30** at the end position **P2**.

In the following, a coupling mechanism of the FFC **30** in the reading unit **22** is explained with reference to FIG. **4** to FIG. **8**.

As shown in FIG. **4** and FIG. **5**, the control board **62** for controlling the light source **221** and the imaging element **222** is attached to the carriage **23**. The control board **62** is fixed to the left side of the carriage **23** via a bracket or the like. The control board **62** is formed in the shape of a flat plate and is disposed to face the left side surface of the carriage **23**. The lower end of the control board **62** is lower in position than a bottom surface **23A** of the carriage **23**.

A connection portion **63** is provided on a lower portion of a surface of the control board **62** facing to the right. The connector **32** attached to an end of the FFC **30** is connected

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to the connection portion **63** so that the FFC **30** is electrically connected to the control board **62**.

A pair of support plates **64** are provided on the bottom surface **23A** of the carriage **23**, wherein the support plates **64** are separated from each other in the front-rear direction. The support plates **64** project downward from the bottom surface **23A**. Shaft holes **66** are respectively formed in left-end portions of the support plates **64**. Support shafts **82** of the swaying support portion **80** are supported by the shaft holes **66** such that the swaying support portion **80** can sway, wherein the support shafts **82** are described below.

The swaying support portion **80** (an example of the support member of the present disclosure) is provided in the reading unit **22**. Specifically, the swaying support portion **80** is attached to the support plates **64** below the bottom surface **23A** of the carriage **23**. The swaying support portion **80** supports the FFC **30**, and displaces, in the up-down direction, a supported portion **30A** (the support point) of the FFC **30** in response to a movement position of the reading unit **22**. In the present embodiment, the swaying support portion **80** supports the FFC **30** such that the supported portion **30A** of the FFC **30** can sway in the up-down direction.

Specifically, the swaying support portion **80** includes an insertion portion **81** and a shaft **82**, wherein the insertion portion **81** supports the FFC **30** in the state where the FFC **30** is inserted therein. The insertion portion **81** is formed in the shape of a flat rectangular parallelepiped, and a pass-through hole **84** is formed to penetrate the insertion portion **81** from a surface to another opposite surface thereof. The FFC **30** is inserted in the pass-through hole **84**. The support shafts **82** are provided on opposite side surfaces of the insertion portion **81** in the front-rear direction. The support shafts **82** are provided on the connection portion **63** side (left side) of the opposite side surfaces. The support shafts **82** are respectively inserted in the shaft holes **66** of the support plates **64**. As such, the swaying support portion **80** is supported by the carriage **23** such that the right end portion of the insertion portion **81** can sway around the support shafts **82** in the up-down direction.

An abutting portion **87** is provided on a back surface (the lower surface) of the insertion portion **81**, wherein the abutting portion **87** is configured to abut on an inclined portion **91** that is described below. The abutting portion **87** is provided on a rear-right portion of the back surface of the insertion portion **81**. The abutting portion **87** is formed in an arc shape so as to reduce a contact resistance with the inclined portion **91**. In addition, the abutting portion **87** is formed in the shape of a semi-cylinder extending in the front-rear direction so as to secure a contact area with the inclined portion **91**.

As shown in FIG. 6, a torsion coil spring **85** (an example of the first biasing member of the present disclosure) is attached to each of the support shafts **82**. The torsion coil springs **85** elastically bias the right-end portion of the insertion portion **81** of the swaying support portion **80** downward. With this configuration, in the state where no other outer force is applied, upon receiving the spring force (biasing force) of the torsion coil spring **85**, the right-end portion of the insertion portion **81** of the swaying support portion **80** is oriented downward, which allows the supported portion **30A** of the FFC **30** to be lower in position than the connection portion **63**. It is noted that the torsion coil spring **85** may be replaced with any other biasing member as far as it can bias the right-end portion of the insertion portion **81** downward.

With the provision of the swaying support portion **80**, when the reading unit **22** is at any position other than the end

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position **P2**, the FFC **30** is oriented downward. With this configuration, the supported portion **30A** is pressed down to a position lower than the connection portion **63** such that the FFC **30** extends diagonally downward from the reading unit **22**, thereby preventing the bending diameter of the bending part **31** from becoming excessively large. As a result, the contact member **27** and the FFC **30** are prevented from contacting each other.

In addition, as shown in FIG. 7 and FIG. 8, the housing **21** includes the inclined portion **91** (an example of the second biasing member of the present disclosure). The inclined portion **91** is formed on a right-end portion of the bottom surface **21A**. As the reading unit **22** moves toward the end position **P2**, the inclined portion **91** biases the insertion portion **81** of the swaying support portion **80** upward against the spring force of the torsion coil springs **85**.

Specifically, the inclined portion **91** is provided on a right-end portion (an end portion on the end position **P2** side) of the bottom surface **21A**. The inclined portion **91** is a rib-like member projecting from the bottom surface **21A** upward along a side surface on the rear side of the groove **26**. The inclined portion **91** is linearly inclined from the flat surface of the bottom surface **21A** diagonally upward to the right. The inclined portion **91** is provided at a position to abut on a lower end of the insertion portion **81** of the swaying support portion **80**, namely, at a position to abut on the abutting portion **87** provided on the back surface of the insertion portion **81**. Specifically, an inclined edge **92** (an example of the inclined surface of the present disclosure), namely an upper surface of the inclined portion **91** abuts on the abutting portion **87**. That is, the inclined portion **91** is provided on the end position **P2** side of the bottom surface **21A**, and includes the inclined edge **92** that is diagonally inclined upward from the bottom surface **21A** toward the end position **P2**.

Since the inclined portion **91** is provided as described above, when the reading unit **22** approaches the end position **P2**, the abutting portion **87** abuts on the inclined edge **92**. When the reading unit **22** further moves toward the end position **P2**, the abutting portion **87** is pressed upward by the inclined edge **92**. This allows the insertion portion **81** of the swaying support portion **80** to be swayed upward around the support shafts **82**. When the reading unit **22** reaches the end position **P2**, as shown in FIG. 8, the right-end of the insertion portion **81** is higher in position than the support shafts **82** and the connection portion **63**. In other words, upon receiving a pressing force from the inclined edge **92**, the right-end of the insertion portion **81** of the swaying support portion **80** is oriented upward, which allows the supported portion **30A** to be higher in position than the connection portion **63**. As the reading unit **22** moves from the start position **P1** toward the end position **P2**, the bending part **31** and the bending diameter become smaller. However, after the reading unit **22** approaches the end position **P2** and the abutting portion **87** abuts on the inclined edge **92**, the bending diameter gradually becomes large. With this configuration, the bending diameter of the bending part **31** does not become excessively small at the end position **P2**, and an excessive bending of the bending part **31** can be prevented. As a result, an excessive load is not applied to the FFC **30**, and a disconnection or a bending distortion of the FFC **30** is prevented.

It is noted that in the above-described embodiment, the swaying support portion **80** includes the pass-through hole **84** that extends in the left-right direction. However, the present disclosure is not limited to this configuration. For example, the present disclosure is applicable to a configu-

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ration where the FFC 30 is inserted in an annular member composed of a wire or the like, and the inclined edge 92 causes the annular member to be displaced in the up-down direction with respect to the connection portion 63, in response to the position of the reading unit 22. Furthermore, in the above-described embodiment, the inclined edge 92 that applies an upward biasing force to the swaying support portion 80 is formed in a linear shape. However, it suffices that the angle and the shape of the inclined edge 92 are set so that the size of the bending part 31 does not reach an allowable maximum size of the bending part 31 while the reading unit 22 moves to the end position P2. Furthermore, in place of the inclined edge 92, an inclined surface may be formed on an upper end of the inclined portion 91 at the same inclination angle as the inclined edge 92.

It is to be understood that the embodiments herein are illustrative and not restrictive, since the scope of the disclosure is defined by the appended claims rather than by the description preceding them, and all changes that fall within metes and bounds of the claims, or equivalence of such metes and bounds thereof are therefore intended to be embraced by the claims.

The invention claimed is:

1. An image reading device comprising:

- a housing;
- a reading unit movably provided in the housing and configured to reciprocally move from a start position to an end position in a reading range;
- a flat cable whose one end is coupled with the reading unit and whose predetermined portion on a side of another end is fixed to the housing, the flat cable being stored in a bent state in the housing;
- a support member provided in the reading unit and configured to support the flat cable and displace, in response to a movement position of the reading unit, a support point of the flat cable in an up-down direction with respect to a coupling portion coupling the one end of the flat cable with the reading unit;
- a first biasing member configured to bias the support member downward; and
- a second biasing member configured to bias the support member upward against a biasing force of the first biasing member in response to the reading unit moving toward the end position.

2. The image reading device according to claim 1, wherein

- upon receiving the biasing force of the first biasing member, the support member allows the support point to be lower in position than the coupling portion, and
- upon receiving a biasing force of the second biasing member, the support member allows the support point to be higher in position than the coupling portion.

3. The image reading device according to claim 1, wherein

- the second biasing member is provided on an end position side of a bottom surface of the housing so as to abut on a lower end of the support member, and includes an inclined surface that is diagonally inclined upward from the bottom surface toward the end position.

4. The image reading device according to claim 3, wherein

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the support member includes, on a lower end thereof, an abutting portion that is configured to abut on the inclined surface at the end position, and

the abutting portion is formed in an arc shape so as to reduce a contact resistance with the inclined surface.

5. The image reading device according to claim 3, wherein

- a groove extending in a moving direction of the reading unit is formed on the bottom surface of the housing, the flat cable is stored in a bottom portion of the groove, and

- the second biasing member is a rib-like member that projects upward from a bottom surface of the groove along one of opposite side surfaces of the groove that face each other in a main scanning direction perpendicular to a moving direction of the reading unit, and the inclined surface is formed on an upper end of the rib-like member.

6. The image reading device according to claim 1, wherein

- the support member supports the flat cable such that the support point can sway in the up-down direction.

7. An image reading device comprising:

- a housing;
- a reading unit movably provided in the housing and configured to reciprocally move from a start position to an end position in a reading range;
- a flat cable whose one end is coupled with the reading unit and whose predetermined portion on a side of another end is fixed to the housing, the flat cable being stored in a bent state in the housing; and
- a support member provided in the reading unit and configured to support the flat cable and displace, in response to a movement position of the reading unit, a support point of the flat cable in an up-down direction with respect to a coupling portion coupling the one end of the flat cable with the reading unit, wherein the support member supports the flat cable such that the support point can sway in the up-down direction, and the support member includes:
 - an insertion portion configured to support the flat cable in a state where the flat cable is inserted therein; and
 - a support shaft provided on a coupling portion side in the insertion portion and supported by the reading unit such that the support member can sway.

8. The image reading device according to claim 7, wherein

- the reading unit includes a pair of support plates that project downward from a bottom surface of the reading unit and are separated from each other in a main scanning direction that is perpendicular to a moving direction of the reading unit.

9. The image reading device according to claim 8, wherein

- the support shaft is provided on each of opposite side surfaces of the insertion portion in the main scanning direction, and provided on the coupling portion side in each of the opposite side surfaces.

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